RF Guided Munitions Proposers' Day

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RF Guided Munitions Concept

- **Exploit dismounted, close-in attack scenario with small aperture, RF communications seeking weapon**
  - **If the dismount (SOF) can detect the emitter then the dismount can attack the (soft target) emitter with an organic weapon (e.g. 81 mm mortar)**
- **Create a passive, all-weather, and inexpensive precision RF seeker capability for multiple weapon types**
  - **Enable a suite of precision and area suppression weapons (ground-to-ground, ground-to-air, and air-to-ground) that home on RF communications energy all using similar RF seeker and guidance technology**
- **Deny enemy use of RF spectrum for communications or jamming**
  - **Counter enemy radar/IR/acoustic signals CCD efforts**
  - **Prevent technical surprise by highlighting vulnerability of US forces**

DARPA Hard Technical Challenge: Quick and Precise Geo-Location of RF Emitters from a Single, High-Velocity, Small Weapon

DARPA Hard Technical Challenge

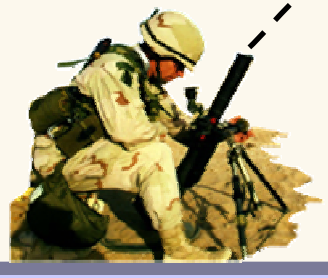
Quick and Precise Geo-Location of RF Emitters from a Single, High-Velocity, Small Weapon

- **Quick: Geo-location estimate must be fast enough (5 sec) to guide a mortar which has only 25-30 seconds of flight time**
- **Precise: Geo-location with an objective radius of an 81 mm mortar (20 m)**
- **RF Emitters: Target communications frequencies from 30 MHz to 3 GHz and multiple waveforms (7 waveform classes)**
- **Single: Emissions received by only a single platform (passive technique)**
- **High-Velocity: Velocity of a mortar varies from 300 m/sec to 100 m/sec**
- **Small: e.g. 81 mm mortar form factor restricts antenna size and distance**

Recent Technology Enablers:

- **Organic detection (cueing) capability (e.g. Wolfpack, MANPACK ACTD, etc.)**
- **Small, lightweight, wideband, and inexpensive RF receivers**
- **Inexpensive memory and processors**
- **Proliferation of guided weapons (IR, laser, GPS, etc.)**

Technical Challenges



Launch Cue → **Geo-locate** → **Maneuver toward target** → **Detonation**

Initial detection, discrimination, and geo-location to <3km x <3km box

<20m accuracy with << λ aperture

Maneuver capability and stable control

3m airburst using GOTS proximity fuze

Phase 1

System Integration

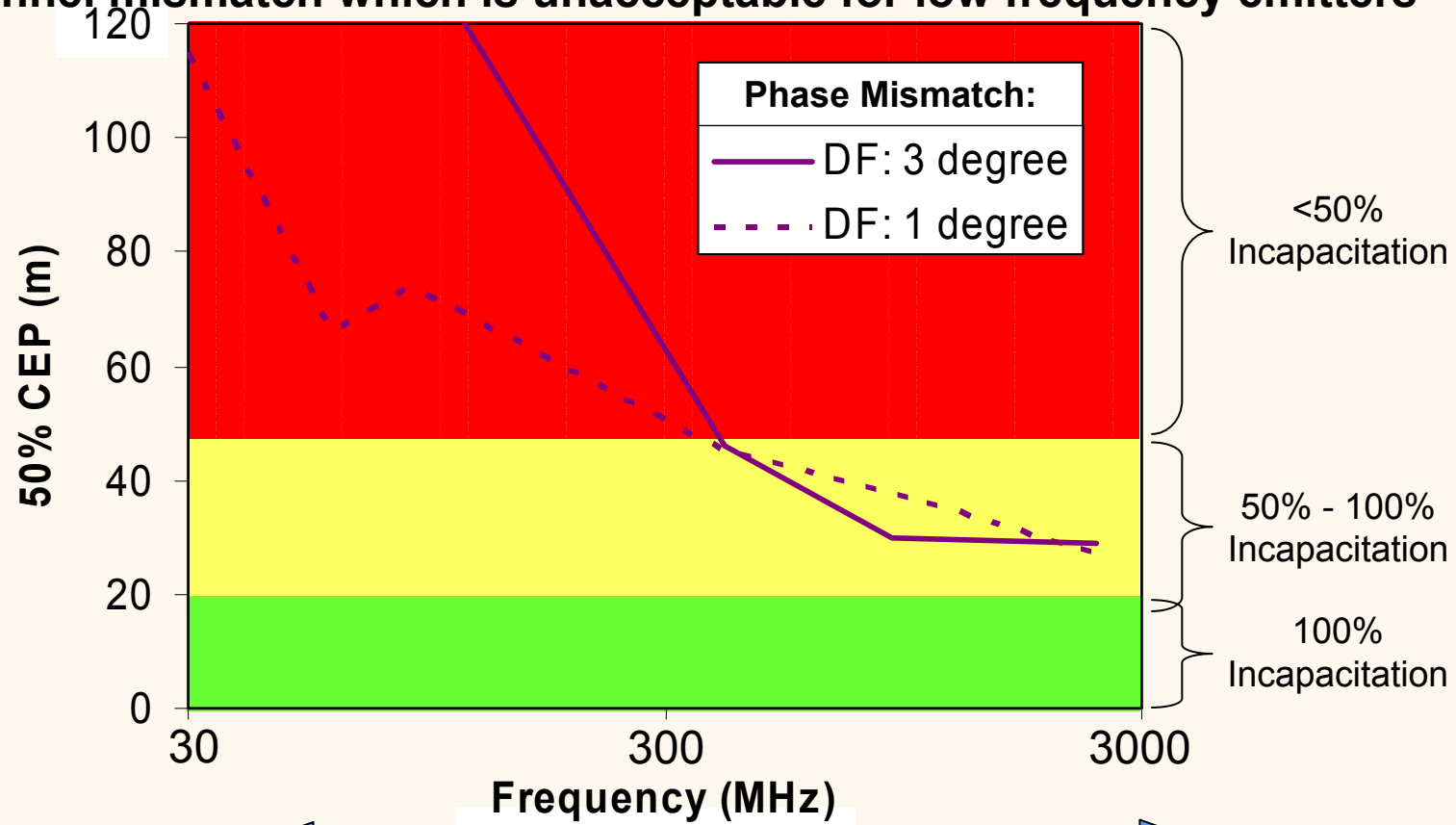
- Miniaturize to a 81mm mortar round
- Cost effective
- Match maneuver, targeting, and munitions capability

Phase 2

Existing technology | Extension of existing technology | Seedling analysis indicates feasible

Geo-location Challenge – Be Green!

Angular precision of classic DF techniques is limited by λ/D, SNR, and channel mismatch which is unacceptable for low frequency emitters



Lower Frequency ← → **Higher Frequency**

- Dominated by channel mismatch which causes a biasing error
  - New concepts will be needed to address this such as exploiting munitions characteristics (e.g. spinning)
- Dominated by imprecision in guidance (GPS/IMU error)
  - More than adequate for this application; further improvement is possible but may not be necessary

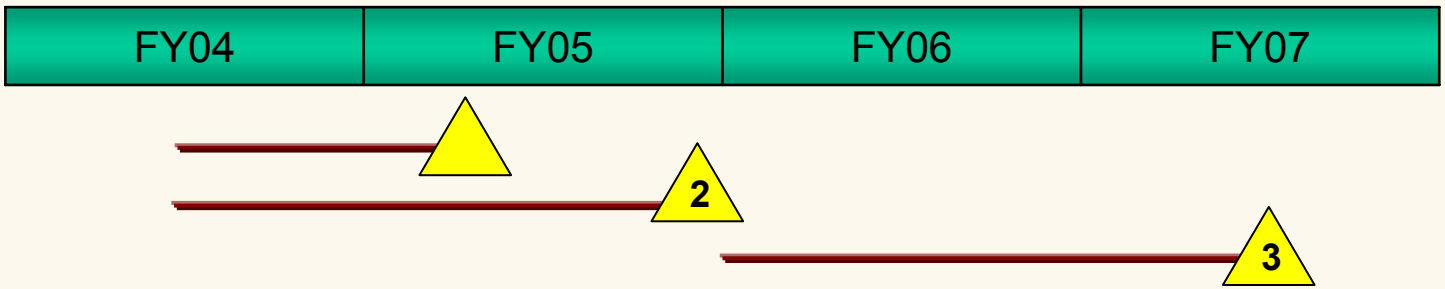
Design/Trade Space

- **Cueing:**
  - The weapon receives cueing information from an external system such as Wolfpack, MANPACK ACTD, ACS, etc.
    - Utilize JASA emitter descriptors (carrier frequency, bandwidth, modulation, etc.) to future proof weapon versus template matching emitter waveforms
- **Geo-location**
  - Despite high SNR condition, the ability of classic DF techniques alone to work well enough to pass the Go/No-Go is questionable due to the limited aperture size/spacing and the (low) frequency range of interest
- **Maneuver toward target**
  - Guidance/control techniques are well known (e.g. ERGM, PGMM, etc.)
- **Detonation**
  - Utilize existing GOTS fuze technology to avoid requalification costs
- **System Integration**
  - Optimizing the relationship between geo-location accuracy and aerodynamic control authority while minimizing weight, volume, and cost and impact on weapon range and effects
    - Integrating the RF Guided Munition kit with the fuze is preferred versus modification of the tail assembly
    - Volume/length will need to be added to the weapon (mortar) for antennas, RF electronics, signal processing, and control surfaces in a manner that minimizes range loss
    - Using GPS is possible but an IMU may be sufficiently capable while being cheaper than SASSM modules – both add a precise targeting capability

Programmatics

Acquisition Strategy

- Potentially multiple performers for Go/No-Go's 1 and 2
  - Phases 1 and 2 are concurrent; continuation of Phase 2 contingent upon passing Go/No-Go 1
- If successful in Go/No-Go 1 and 2, potentially multiple performers move on to Go/No-Go 3 to add capability to different weapons pursuant to MOA with transition sponsor



RF Guided Munitions Phase 1

Objective: Validate Geo-location Techniques (12/04)

- Develop small, moving aperture geolocation techniques
- Develop techniques for the reduction of channel mismatch errors

Go/No-Go:

- Detect and geo-locate a single RF source in near-real time during captive carry on an aircraft flying a ballistic arc
  - 50% of the final geo-location estimates must be within 20 m of the target emitters at 30 MHz, 300 MHz, 1 GHz, and 3 GHz sources

RF Guided Munitions Phase 2

Objective: Validate Geolocation Performance Against Multiple Emitters in Multipath Environments (9/05)

- Develop multipath mitigation and multiple user discrimination techniques, such as subspace tracking techniques
- Develop mortar-sized electronics and guidance package

Go/No-Go:

- Detect and geolocate a target RF waveform emitter in real-time among multiple, similar RF waveform emitters (densities up to 1 emitter/km^2) in a multipath environment after soft launch
  - 50% of mortar rounds must impact within 20 m of a target waveform emitter at 30 MHz, 300 MHz, 1 GHz, and 3 GHz
- Establish MOA with transition partner

RF Guided Munitions Phase 3

Objective: System Integration and Test (4/07)

- **Demonstrate tube launch of an 81 mm RF seeking mortar round after receiving a field realizable cue from an external geo-location system**
  - **In conjunction with MOA transition partner**

Go/No-Go:

- **<u>After receiving a field realizable cue from an external geo-location system</u>, detect and geo-locate a target RF waveform emitter in real-time among multiple, similar RF waveform emitters (densities up to 1 emitter/km^2) in a multi-path environment after tube launch using (inert) RF guided mortar**
  - **50% of weapons must impact within 20 m of a target waveform emitter at 30 MHz, 300 MHz, 1 GHz, and 3 GHz**

Parameters May Vary Depending on MOA Transition Partner

Phase 3 Potential Weapons Hosts

- **Ground-Ground**
  - Mortars (81/120mm)
  - Artillery (105/120/155mm)
  - ATGMs (Javelin, etc.)
  - NetFires (PAM/LAM)
- **Air-Ground**
  - Hydra (70mm) rockets
  - LOCASS
  - Hellfire
  - Maverick
  - Kits for dumb bombs (JDAM, Paveway, SDB, etc.)
  - BAT/Viper
- **Ground-Air**
  - Stinger

A Non-Exhaustive List - Insert Your Weapon of Interest If You Don't See It

Questions?